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Application No.: 10/780,244
Filed: February 17, 2004
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Listing of Claims

This listing of claims replaces all prior versions of the claim set.

1. (Canceled).
2. (Currently Amended) ~~The method of claim 1, further comprising~~
A method of forming a semiconductor device comprising:
patterning a metal-gate layer and a gate polysilicon layer to form a gate pattern
comprising a gate polysilicon pattern and a metal-gate pattern;
covering sidewalls of the metal-gate pattern with an oxidation barrier layer, wherein the
oxidation barrier layer comprises metal; and
forming the oxidation barrier layer on the sidewall of the metal gate pattern using
chemical vapor deposition (CVD) or an atomic layer deposition (ALD).
3. (Currently Amended) The method of claim [[1]]2, wherein the oxidation barrier layer
comprises at least one of an oxide, nitride, or oxynitride of the metal.
4. (Currently Amended) The method of claim 3, wherein the ~~oxidation barrier layer~~
~~comprises a metal~~ comprises at least one of the following: selected from the group consisting of
aluminum (Al), tantalum (Ta), titanium (Ti), hafnium (Hf) and gold (Au).
5. (Currently Amended) ~~The method of claim 1, further comprising~~
A method of forming a semiconductor device comprising:
patterning a metal-gate layer and a gate polysilicon layer to form a gate pattern
comprising a gate polysilicon pattern and a metal-gate pattern;
covering sidewalls of the metal-gate pattern with an oxidation barrier layer, wherein the
oxidation barrier layer comprises metal; and
sequentially forming a gate insulator layer, a gate polysilicon layer and a metal gate layer
on a semiconductor substrate prior to the patterning step,

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wherein the covering step comprises depositing a metal layer and oxidizing or nitrifying the deposited metal layer.

6. (Currently Amended) ~~The method of claim 1,~~
A method of forming a semiconductor device comprising:
patterning a metal-gate layer and a gate polysilicon layer to form a gate pattern
comprising a gate polysilicon pattern and a metal-gate pattern; and
covering sidewalls of the metal-gate pattern with an oxidation barrier layer, wherein the
oxidation barrier layer comprises metal,

wherein the oxidation barrier layer comprises aluminum oxide (Al_2O_3), and wherein the covering step comprises:

forming an aluminum layer using a CVD method by supplying methylpyrrolidine alane (MPA) as a source gas and argon (Ar) of 100sccm as a carrier gas at a temperature of between about 135~145°C and at a pressure of between about 0.1~1.1 Torr; and

oxidizing the aluminum layer in an enriched oxygen environment.

7. (Currently Amended) The method of claim 5 [[1]], wherein the oxidation barrier layer has a thickness of between about 5~100Å.

8. (Currently Amended) ~~The method of claim 1, further comprising~~
A method of forming a semiconductor device comprising:
patterning a metal-gate layer and a gate polysilicon layer to form a gate pattern
comprising a gate polysilicon pattern and a metal-gate pattern;
covering sidewalls of the metal-gate pattern with an oxidation barrier layer, wherein the
oxidation barrier layer comprises metal; and

forming a barrier metal layer between the metal gate layer and the polysilicon layer, and wherein the gate pattern comprises a stacked gate polysilicon pattern, barrier metal pattern and metal gate pattern.

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9. (Original) The method of claim 8, wherein the barrier and/or metal gate layer comprises tungsten.

10. (Currently Amended) The method of claim 8 [[7]], wherein the barrier metal layer comprises tungsten nitride (WN) or titanium nitride (TiN).

11. (Currently Amended) The method of claim 8 [[7]], wherein the oxidation barrier layer is selectively configured to cover substantially only the sidewall(s) of the metal gate layer and the barrier metal layer.

12. (Currently Amended) The method of claim 5 [[1]], further comprising forming a capping layer on the metal-gate layer, wherein the capping layer is patterned when the metal-gate layer and the gate polysilicon layer are sequentially patterned, thereby forming a stacked gate pattern comprising, in serial order, a gate polysilicon pattern, a metal-gate pattern and a capping pattern.

13. (Currently Amended) The method of claim 5 [[12]], further comprising forming a spacer layer to substantially cover a sidewall of the gate pattern including about: (a) the sidewall(s) of the polysilicon pattern; (b) sidewall(s) of the oxidation barrier layer over the metal-gate layer; and (c) the sidewall(s) of the capping pattern.

14. (Currently Amended) The method of claim 5 [[1]], further comprising forming an impurity-doped region in the semiconductor substrate at opposing sides of the gate pattern using the gate pattern as an ion-implantation mask.

15. (Currently Amended) The method of claim 5 [[1]], further comprising thermally treating the semiconductor substrate having the gate pattern with the oxidation barrier layer under an oxygen-enriched environment.

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16. (Currently Amended) The method of claim 15, wherein the thermally treating under the oxygen-enriched environment comprises supplying nitrogen as a carrier gas, comprising oxygen, and hydrogen at a temperature of between about 750~950°C and a ratio of oxygen/hydrogen of between about 0.5~1.3.

17. (Currently Amended) A method of forming ~~an integrated circuit device having a metal gate electrode comprising:~~

~~forming a stacked gate pattern onto a target substrate, the gate pattern comprising a metal-gate pattern on a target substrate with opposing first and second surfaces and at least one sidewall;~~

depositing a metal layer; and

oxidizing or nitrifying the deposited metal layer to form an oxidation barrier layer covering sidewalls of the metal-gate pattern.

~~and covering at least a portion of the at least one sidewall of the metal-gate pattern with an oxidation barrier layer substantially without covering a sidewall of an adjacent gate polysilicon layer with the oxidation barrier layer.~~

18. (Currently Amended) A method according to Claim 17, wherein forming a the covering the at least one sidewall of the metal-gate pattern comprises;

forming a polysilicon gate layer and a metal gate layer on the target substrate; and

patterning the metal layer and the polysilicon layer to form a polysilicon-gate pattern and the metal-gate pattern.

~~conformably covering substantially the entire outer surface of the sidewall(s) of the metal-gate pattern with the oxidation barrier layer.~~

19. (Currently Amended) A method according to Claim 18, wherein the metal gate layer comprises tungsten and the metal layer comprises aluminum, tantalum, titanium, hafnium, and gold. ~~gate pattern comprises a barrier metal layer abutting the metal-gate pattern, and wherein the covering step is carried out to also substantially cover the sidewall(s) of the barrier metal layer~~